5.0 CASE STUDIES

Five case studies were evaluated using the OASIS modeling system adapted to the Delaware River Basin. These are not comprehensive studies, but are examples of OASIS model runs and performance measures to demonstrate how operating alternatives that address specific issues can be evaluated. The case studies do not reflect any policy or proposals by the DRBC.

Three of the case studies were for the Upper Basin, defined as the watershed above Montague and including the NYC reservoirs. The remaining two are in the Lower Basin – one on Tulpehocken Creek (Blue Marsh Reservoir) and the other on the Pohopoco Creek (Beltzville Reservoir). Originally, a case study on the Lackawaxen River was envisioned instead of one on the Lehigh. But during the course of the project, HydroLogics was contracted by PPL to develop a much more detailed model of Lake Wallenpaupack, which would have been the focus of the case study. A large number of case studies were performed by HydroLogics and by PPL independently, and the results were presented to the DRBC Flow Management Technical Advisory Committee in October of 2001. Given that operations on the Lackawaxen are currently a matter of discussion between DRBC and PPL (both HydroLogics' clients) and that a significant number of studies had already been done, a case study concerning Pohopoco Creek below Beltzville Reservoir was deemed more appropriate.

The Upper Basin case studies were prepared for use in the sample Computer Aided Negotiation (CAN) session conducted by HydroLogics at the DRBC on June 5, 2001. At that time, DRBC's PP460 run of the Daily Flow Model represented the base case for modeling purposes. That is, it was the best available representation of the system as currently operated. The Upper Basin studies were copied from and ultimately compared to this run (draft_base_run). Since June 2001, the base case run (final_base_run) has been updated to include modifications for Wallenpaupack operations and a new routine for balancing the NYC reservoirs. The Tulpehocken Creek, Pohopoco Creek case studies were both based on this new version of the base run, but the Upper Basin case studies were run with the original model.

5.1 Upper Basin Case Studies

5.1.1 Case Study 1 - Trout Unlimited Proposal

The first of the Upper Basin case studies (Trout_Unlimited_Proposal) modeled a proposal from Trout Unlimited that called for much higher minimum releases from the NYC reservoirs. Fisheries releases from the NYC reservoirs have been a long-standing issue, and DRBC has adopted several revisions to the "Good Faith Recommendations" designed to enhance trout fisheries. NYSDEC has developed Instream Flow Incremental Methodology (IFIM) models to determine available trout habitat in the streams and also developed models that predict water temperatures at several points as a function of reservoir release and maximum and minimum daily air temperatures. The latter model is currently used to determine minimum desirable flows on a daily basis.

The objective of the Trout Unlimited proposal is to improve cold water fisheries conditions in the West Branch, East Branch, and Neversink by substantially increasing minimum flows. The following is a brief description of the proposal. Under "normal" or "watch" conditions, the Trout Unlimited minimum releases range from 600 cfs (summer) to 300 cfs (winter) from Cannonsville, 500 cfs to 150 cfs from Pepacton, and 228 cfs to 70 cfs from Neversink (see Table 5.1). These flows are more than four times higher than the minimum releases under current operating policies. (Because the minimum releases are so much higher, they are assumed to substitute for directed releases made to meet the Montague target. Consequently, no directed releases are made in the Trout Unlimited proposal run.) The Trout Unlimited proposal reduced the minimum releases by half during drought "warning" and "drought" conditions. This compares to a 15 percent reduction during "warning" and an approximately 80 percent reduction during "drought" under current operating policies. (This comparison is somewhat skewed because the normal minimums in the base run are much lower than those proposed by Trout Unlimited.)

Table 5.1, Minimum Releases Used for the Trout_Unlimited_Proposal Case Study

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pepacton	250	200	200	300	400	500	500	500	400	150	200	250
Neversink	150	150	200	228	200	150	100	100	100	70	100	150
Cannonsville	300	300	300	300	425	600	600	600	450	300	300	300

The performance measures used to evaluate this run included flows in each of the individual streams, storage in the NYC reservoirs, storage in Lower Basin reservoirs, and the location of the Delaware Estuary salt front. These are displayed in time series plots in Figures 5.1 through 5.6, below. Note that the salt front model used in these runs is a linear regression-based approximation of the two-dimensional hydrodynamic models currently used by DRBC. The regression model was developed by students at Cornell University, then modified by HydroLogics to get a better "eyeball fit." It is quite crude and is not sensitive to potential changes in channel geometry. It is used here only for the purposes of comparing model runs.

Even with no directed releases, the impact of the proposal on other water users in the Basin is striking. Filling of the NYC reservoirs becomes a rare event. Using the current rules that define drought status, the Basin is in drought almost 45-percent of the time as compared to 11-percent of the time under the existing operating policies. Average NYC diversions are reduced by about 21-percent or almost 160 mgd. Figure 5.1 compares the simulated storage in the NYC reservoirs between the base case and the Trout Unlimited proposal.

In contrast to the effects on the NYC reservoirs, the impact on Lower Basin storage is modest. Additional drawdown does occur, however, because releases to meet the Trout Unlimited targets are smaller and more poorly timed than the directed releases which would have been made. The impact on the Lower Basin occurs primarily because the lower storage in the NYC reservoirs results in minimal releases from those reservoirs at precisely the time water is needed to repel salinity in the Delaware Estuary. This, in turn, results in higher releases from the Lower Basin reservoirs to maintain required flows at Trenton. Figure 5.2 shows the impact of the proposal on simulated Lower Basin storage using hydrology of the 1950s, which includes two serious drought events.

Figure 5.3 shows that the Trout Unlimited proposal has a positive, but generally very small impact on the position of the salt front in the Estuary. The larger releases from the New York City reservoirs do move the front slightly downstream, but they are not timed very well for salinity repulsion.

Figures 5.4, 5.5, and 5.6 show how, during a typical period (1954 and 1955), the Trout Unlimited proposal achieves the objective of maintaining higher minimum flows in the Upper Delaware tributaries below the NYC reservoirs. It is important to note that the NYC reservoirs rarely fill under the Trout Unlimited rules. Uncontrolled spills and the resulting high flows in the river reaches downstream of the reservoirs are also rare events. (In contrast, under current operating policies, Cannonsville and Pepacton spill every few years and Neversink somewhat less frequently.)

In summary, this case study shows that the implementation of the minimum flows proposed by Trout Unlimited would have substantial impacts on other water users in the Delaware Basin and on New York City because drought conditions would be triggered more frequently. The case study also illustrates that the demands on the system are such that it is important to target releases as closely as possible to meet the most critical needs with the minimum amount of water. Large, continuous minimum flows that greatly exceed natural flows during low flow periods have the most significant impact on storage for water supply. In contrast, rules that seek to maintain more natural habitat levels at low flows would have less of an impact. Additional information is still needed to quantify the fisheries benefits of the Trout Unlimited proposal with those of the existing operating rules.

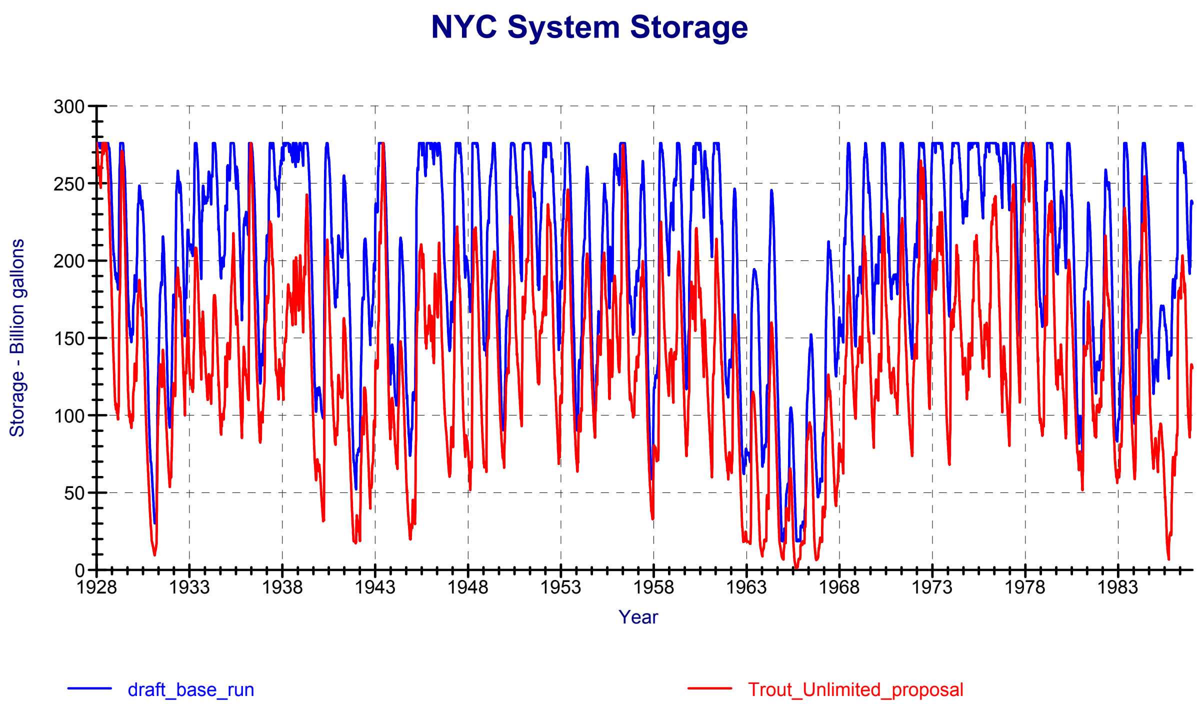
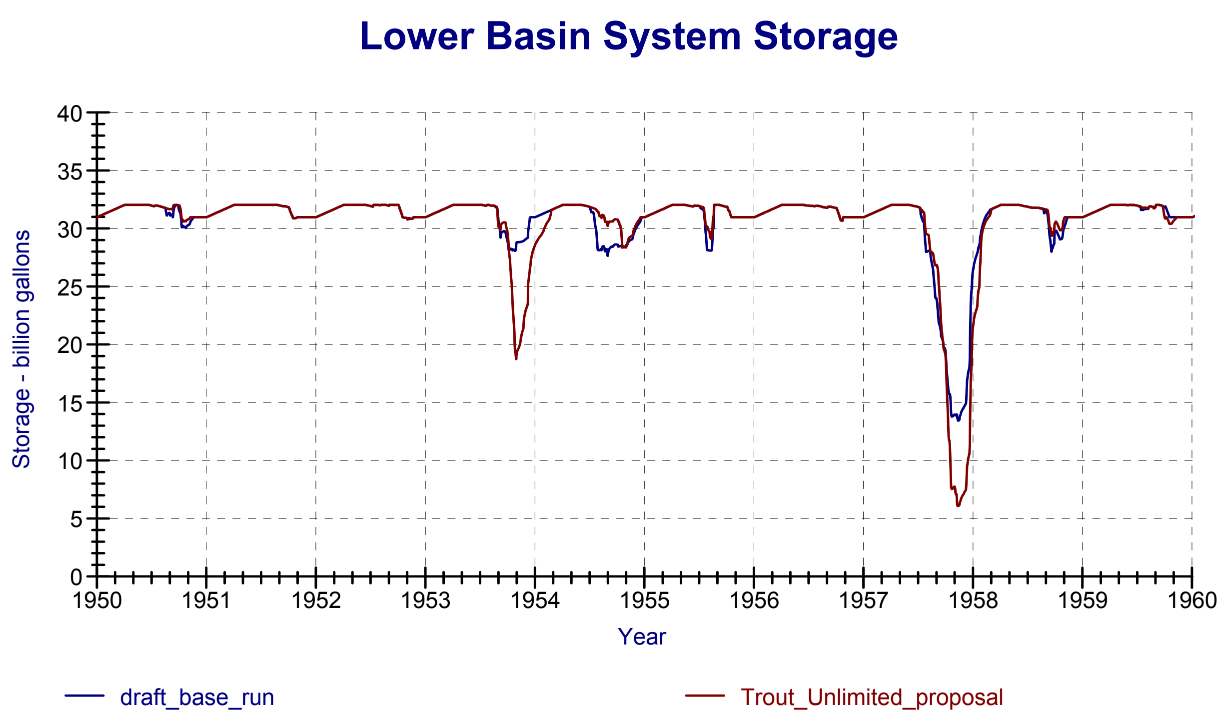


Figure 5.1



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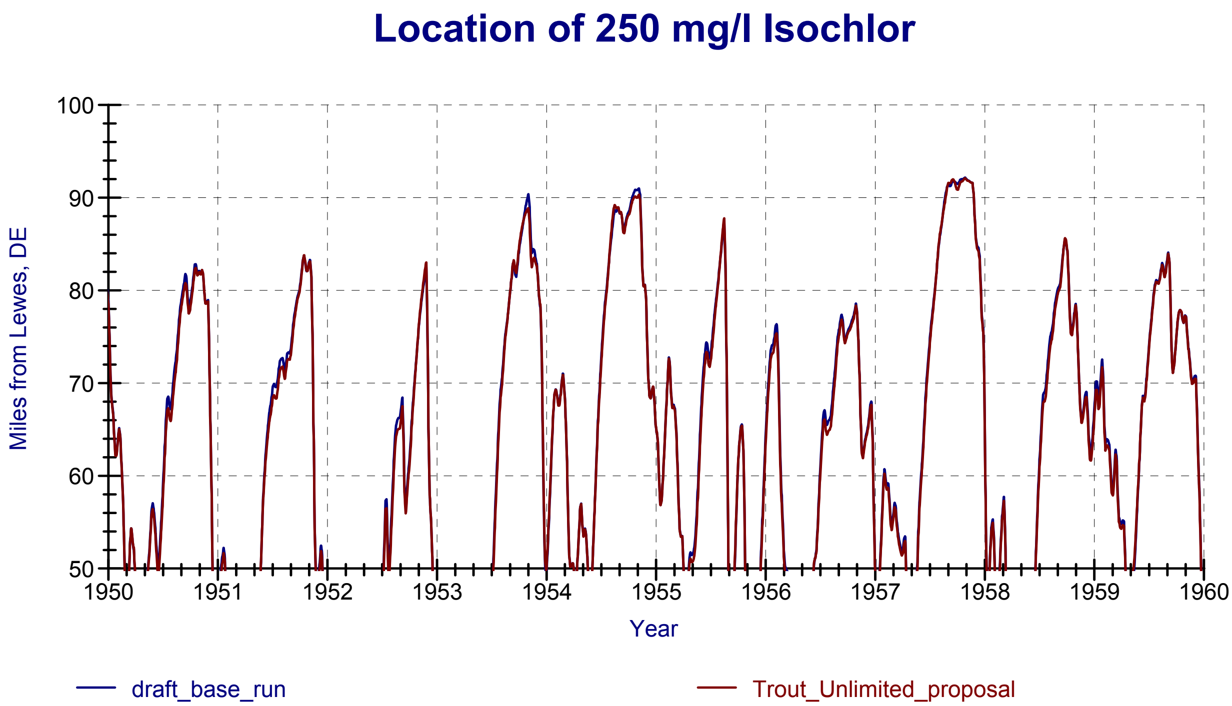
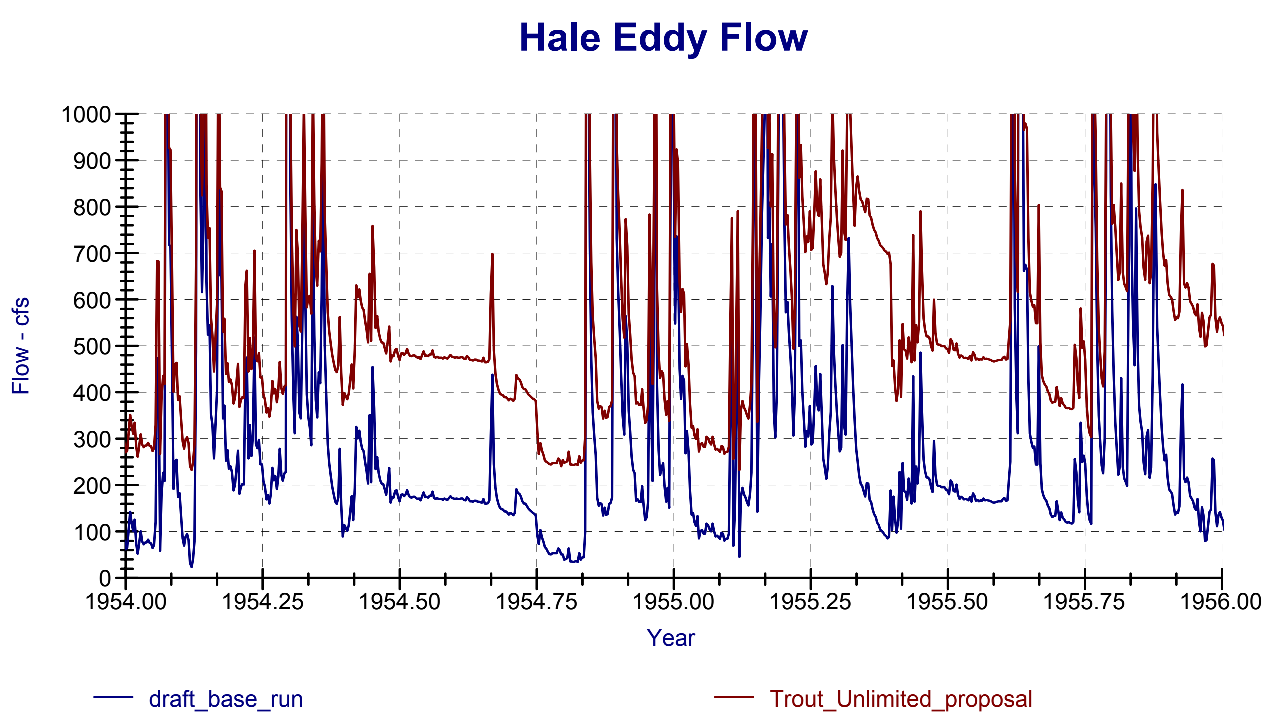


Figure 5.3



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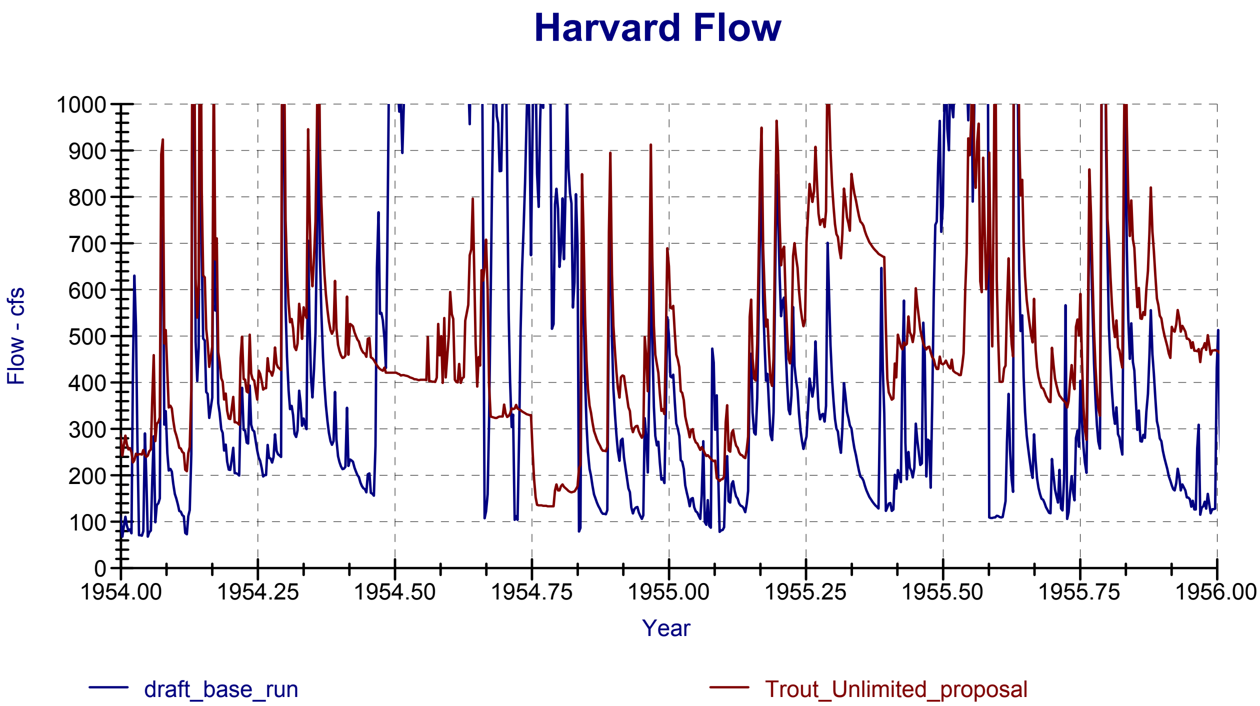

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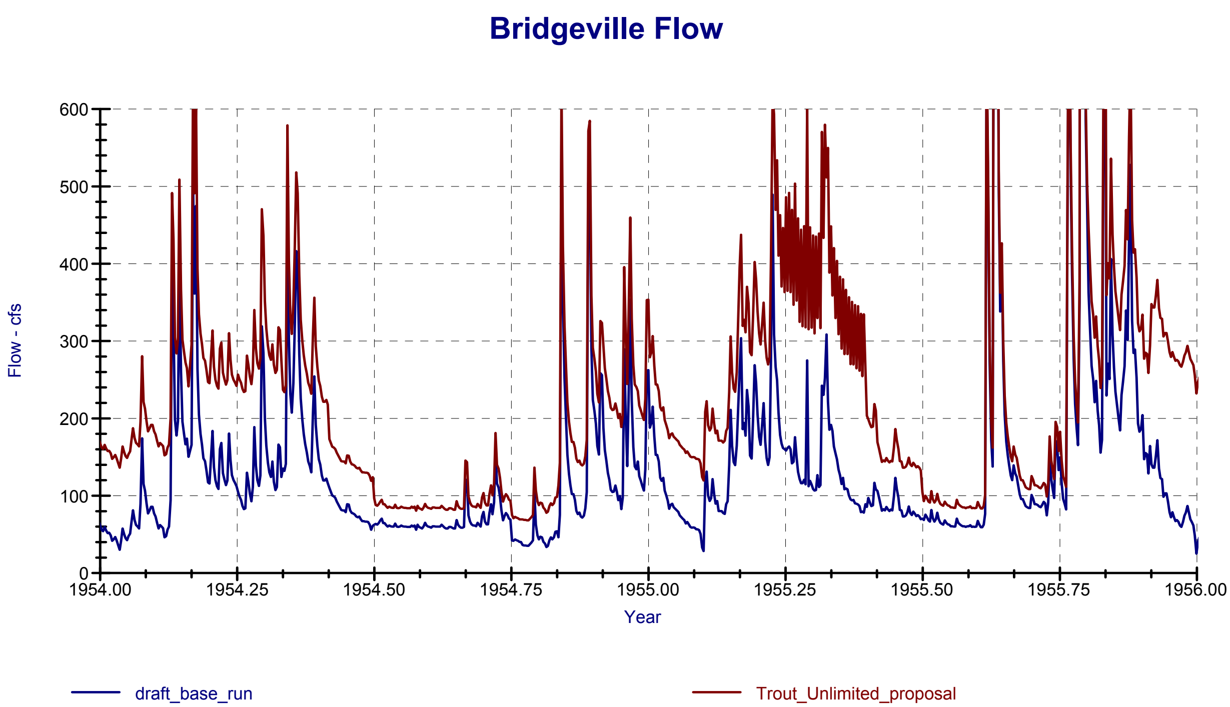


Figure 5.6

5.1.2 Case Study 2 - NYC Reservoirs Operated to meet Trenton Target

The Montague flow target was specified in the 1954 Supreme Court Amended Decree in order to maintain an “equitable apportionment” of the waters of the Delaware River. The second of the Upper Basin case studies (Trenton_Target_only) was aimed at illustrating the improvements in water supply reliability that could be obtained by changing the focus of releases from meeting fixed flow targets at Montague and Trenton to meeting salinity-based flow targets at Trenton alone. This case study replaced the Montague target with a requirement that the NYC reservoirs be used in conjunction with Lower Basin reservoirs to meet the Trenton target.

The rules (operating assumptions) tested in this case study call on the NYC reservoirs to make releases of 70 percent of the water required to meet Trenton flow targets in the late spring and summer (May through August) or when the Lower Basin reservoirs fall to low levels. This has the effect of postponing the drawdown of the Lower Basin reservoirs until after the recreation season. In the fall and winter, the Lower Basin reservoirs are utilized to meet all of the Trenton target, until they are at minimal levels. The rules utilize the water in the Lower Basin reservoirs in this way because the probability that they will refill and spill in the spring is much higher than for the NYC reservoirs. By utilizing water that is likely to be spilled in the spring, these rules maximize the total combined storage available in the Upper and Lower Basins during droughts.

Such an operational change would represent a departure from the requirements of the 1954 Amended Decree which places the burden of maintaining downstream flows on the New York City reservoirs. The construction of the downstream reservoirs in the 1970s represented an effort by the DRBC to provide augmentation of downbasin flows over and above what was being provided by the NYC reservoirs, rather than as substitutes for the NYC reservoir releases. In addition, the potential impacts on the river of reduced flows at Montague resulting from this hypothetical operation would need to be examined.

The rules for this case study also change the way in which the Trenton target is calculated. Current rules vary the required flow based on storage. They are replaced with the rules that determine flow requirements based on the position of the salt front and the time of year. Thus, releases from both the NYC and Lower Basin reservoirs are substantially reduced when the salt front is further down the Estuary and increased as it progresses upstream toward Trenton, even during what would now be considered normal operating conditions. This has the effect of lowering the flow target at Trenton much of the time, but, since uncontrolled inflow at Trenton is normally much more than 3,000 cfs, the effect of reducing the target on actual flows is not often apparent.

The performance measures used to evaluate the results of this case study were storage in the NYC Reservoirs, minimum flows below the NYC reservoirs, storage in the Lower Basin reservoirs, the frequency and duration of “watch,” “warning,” and “drought” conditions, and the position of the salt front in the Delaware Estuary.

The effectiveness of these rules at preserving storage while meeting the Trenton target is quite clear. Figure 5.7 compares the storage in the NYC reservoirs with the storage in the base run over the period of record. Figure 5.8 shows the same differences for the simulated decade of the 1950s. With the exception of the drought of the 1960s, when storage is simply inadequate to meet all instream flow requirements and water supply demands in both runs, the minimum storage in the reservoirs is typically 25 to 50 billion gallons higher at the worst point in the drought. By comparison, the capacity of all of the Lower Basin reservoirs combined is about 30 billion gallons. Because the Lower Basin reservoirs refill every year, this means that much additional water is available in the later years of a multi-year drought. As a result of the increased storage, the frequency and duration of various basinwide drought alert conditions are substantially reduced. “Watch” days are reduced by 15 percent, “warnings” by 40 percent, and “droughts” by 43 percent. The reduction in “watches,” “warnings,” and “droughts” allows New York City to divert an additional 34 mgd on average over the course of the simulation. Likewise, diversions to New Jersey are also increased.

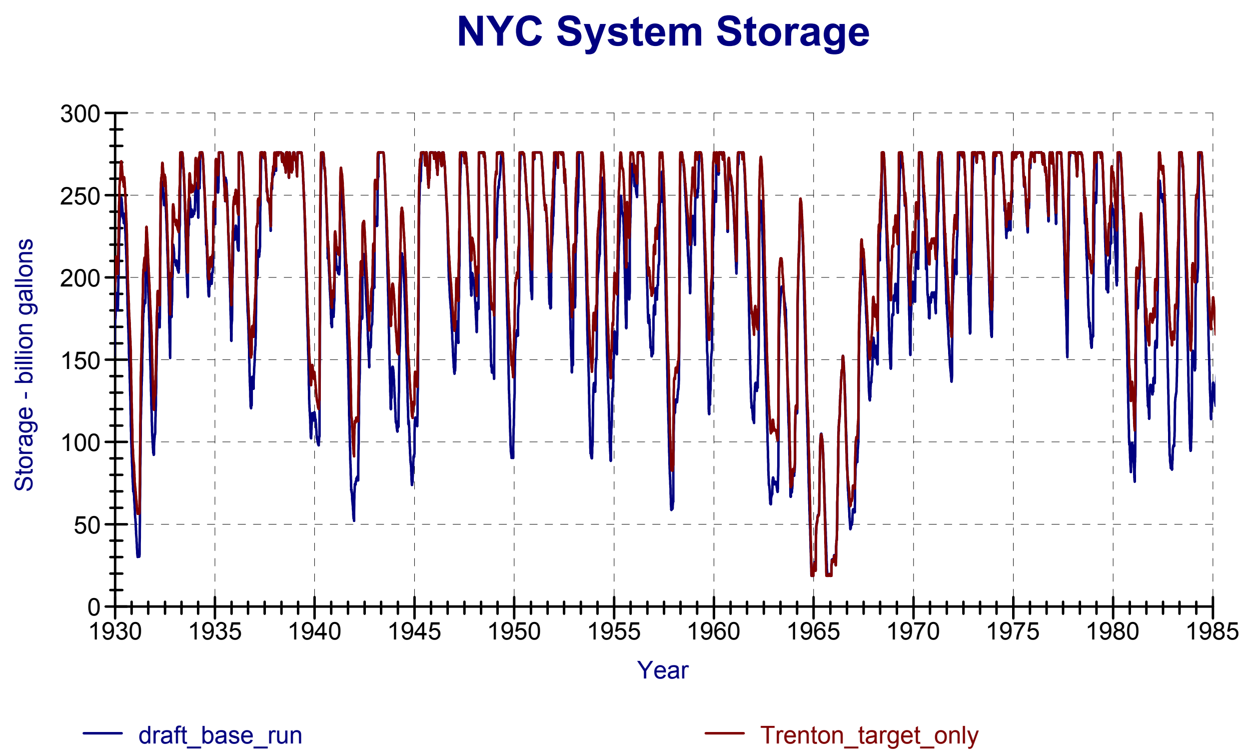


Figure 5.7

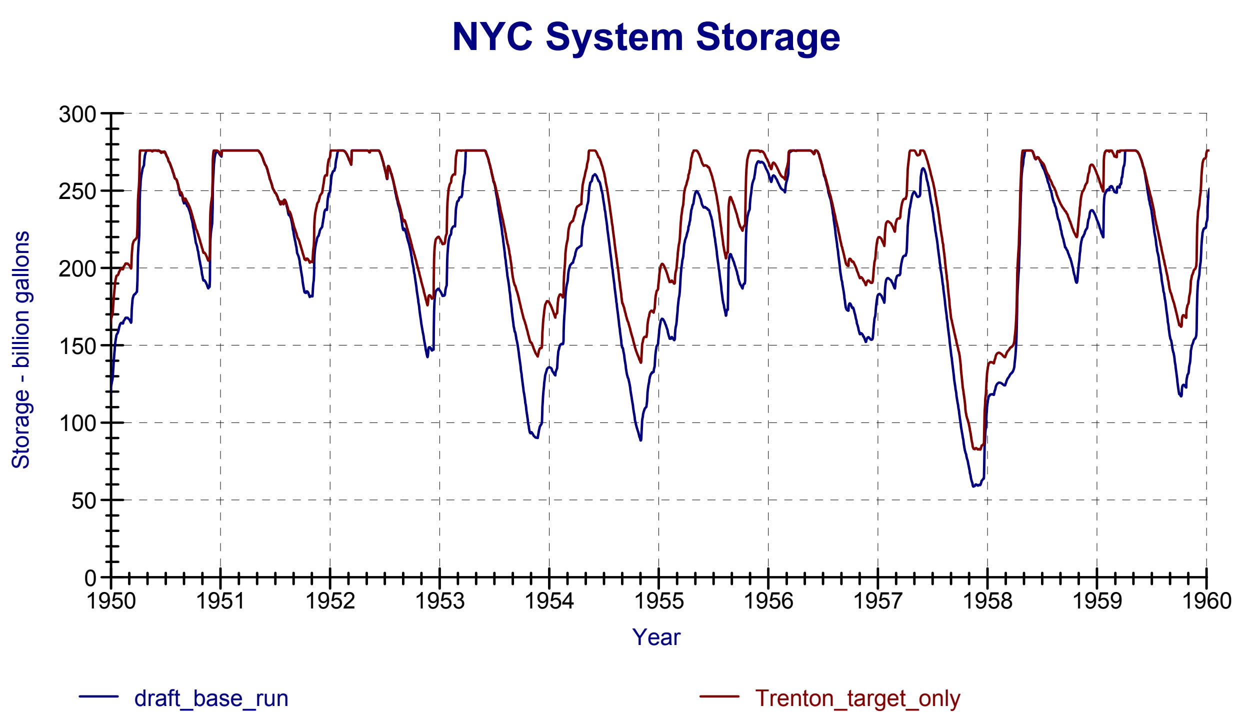


Figure 5.8

Figure 5.9 shows typical impacts on the Lower Basin reservoirs through the decade of the 1950s. In many years, there is little or no impact on Lower Basin storage, but during droughts, the winter drawdowns are substantial. But, as stated previously, this provides significant reliability benefits for the entire system. The change in operations generally raises the minimum flows in the river reaches below the NYC reservoirs. Figure 5.10 shows this for Hale Eddy over a short portion of the 1950s. Figure 5.11 illustrates how the operating policies tested in this case study tend to move the salt front downstream in severe droughts but allow it to come slightly further upstream under more normal conditions. Overall, this case study demonstrates that there may be potential for improving the performance of the system as a whole.

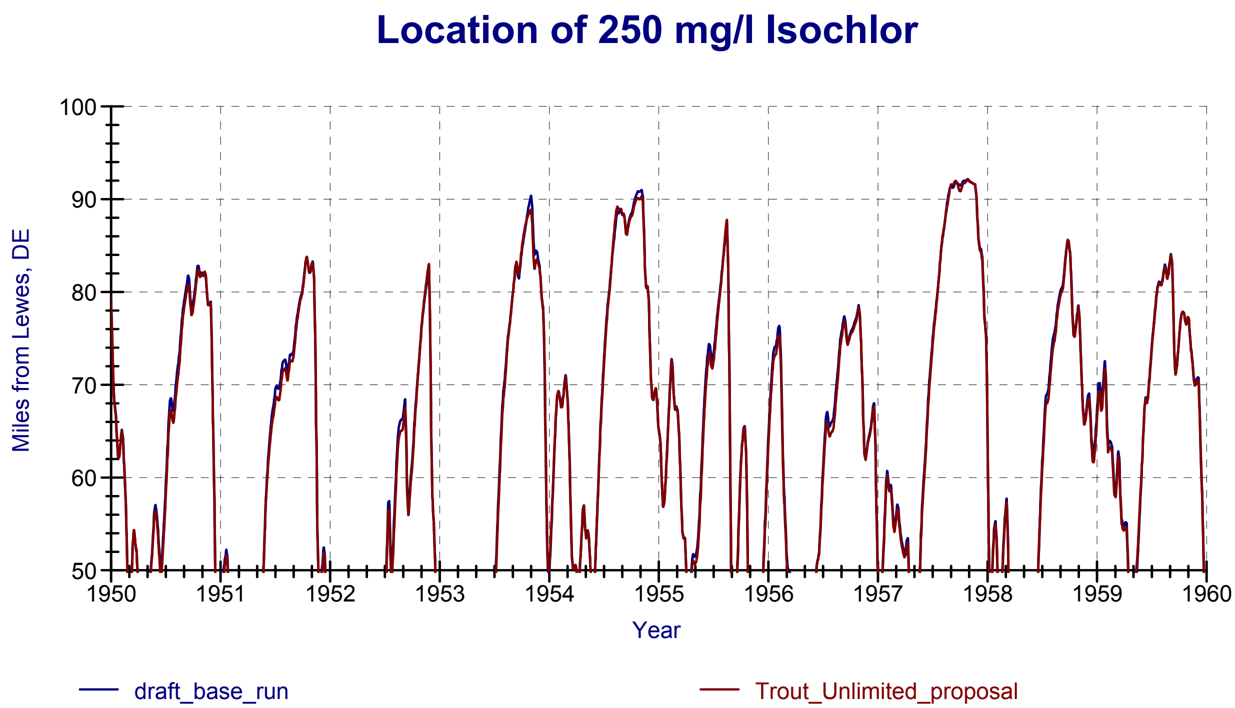


Figure 5.9

Upper Basin instream flow impacts are critical in evaluating these kind of operating rules. Impacts on temperature and spawning habitat for trout are particularly important, as are recreational flows. These have not been fully evaluated here and would need to be evaluated as a part of a complete investigation of any proposed operating rules. It is important to note that the amount of additional storage made available by using rules that follow the same principles as the rules tested in this case study could be used to improve fisheries and recreation conditions as well as to increase the reliability of supply.

5.1.3 Case Study 3 - NYC Reservoir Balancing

This case study (NYC_balancing) illustrated the impacts that current NYC operating policies have on the relative flows in the West Branch, East Branch, and Neversink Rivers. The base run for the Upper Basin attempts to balance storage in the upstream reservoirs on a percent-full basis. It does not specify, beyond the minimum releases, which reservoirs are to be used to meet NYC demands or directed releases to meet the Montague target. In reality, the quality of water in Neversink Reservoir is best, followed by Pepacton, and then Cannonsville. NYC naturally tries to divert the highest quality water for domestic supply.

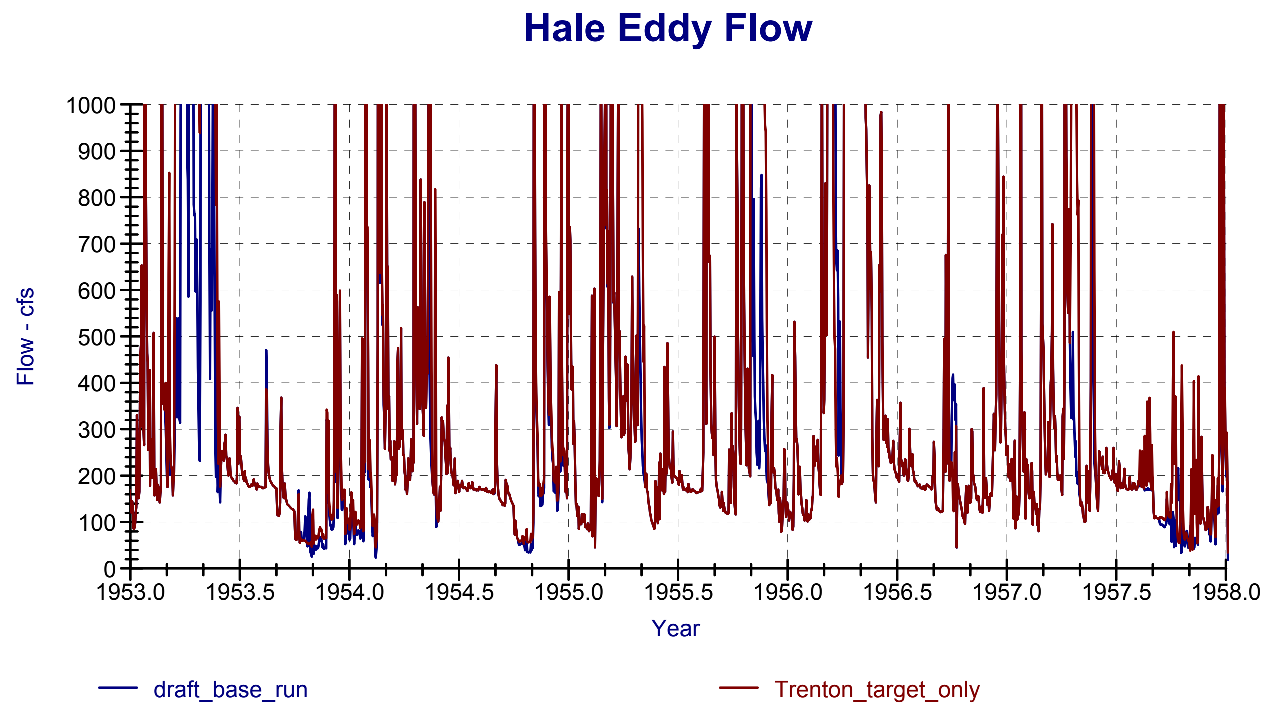


Figure 5.10

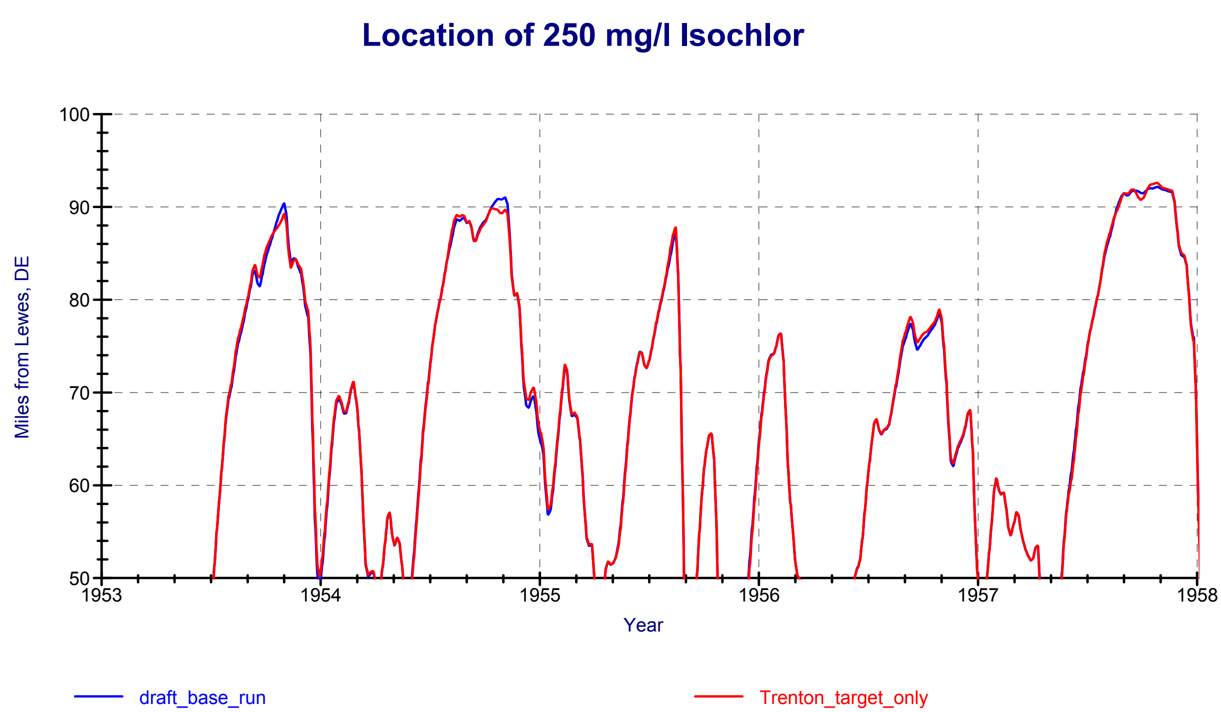


Figure 5.11

The rules tested (operating assumptions) in this case study changed the balancing procedures to maximize NYC diversions from Neversink Reservoir, then Pepacton Reservoir in a way that closely resembles NYC's current operations. This was done by creating a small zone at the top of Neversink Reservoir. Any water in this zone is given first priority for diversion to NYC. In effect, this minimizes spills from Neversink. In addition, a small penalty is applied to downstream releases in excess of minimums from Pepacton and Neversink Reservoirs. This has the effect of forcing most releases to meet the Montague target to be taken from Cannonsville Reservoir.

The performance measures used in this case study are the diversions from each reservoir to NYC and the relative flows in the West Branch, East Branch, and Neversink Rivers.

The new rules are very effective at changing the relative diversions to NYC from the three reservoirs. Cannonsville diversions go from an average of 380 mgd in the base run to 246 mgd in the case study run. Pepacton and Neversink diversions to NYC increase from 235 and 133 mgd to 364 and 136 mgd, respectively. Changes in instream flows are most noticeable on the West and East Branches because of the large shift in diversions from Cannonsville (West Branch) to Pepacton (East Branch) between the runs. These are illustrated in Figures 5.12 and 5.13.

5.2 Lower Basin Case Studies

5.2.1 Case Study 4 - Rafting Releases at Beltzville

This case study examined the impacts of instituting a summer rafting release from Beltzville Reservoir. Whitewater rafting currently does not take place on Pohopoco Creek downstream of Beltzville Dam.

For the purposes of this case study the release was set to 235 cfs for six hours, with two hours of ramping (gradual changes from and back to minimum flows) on each side of the rafting release, which equates to a daily average flow of 105 cfs. The relationship between flow and rafting quality is not known so this is an arbitrary, but large, flow for Pohopoco Creek. The releases**,** as modeled, would be made on both Saturday and Sunday on all weekends from May through September, as long as both Upper Basin and Lower Basin conditions are normal. The releases stop when conditions in the Upper Basin fall to "watch" or conditions in the Lower Basin fall to "warning ."

Performance measures selected for this case example are the flows below Beltzville dam, NYC reservoir storage, and Lower Basin storage.

Figure 5.14 illustrates the hypothetical release pattern for a typical year. Figures 5.15 and 5.16 show the impact on Beltzville and Lower Basin storage. Those impacts are negligible. Changes in minimum flows in the Lower Basin have the potential to affect releases from the Upper Basin reservoirs, but these impacts are also negligible. Based only on these indicators, a program to develop a recreational resource below Beltzville might be accommodated with minimal impact on other Basin activities. There may be impacts on other local uses, such as temporary reduction in fishing access or even minor flooding, and it would be important to consider these potential impacts further. Although the impact on Lower Basin storage appears small, a 60-year analysis of Lower Basin drought frequency and any potential impacts on Merrill Creek operation would be required to more fully evaluate such an alternative. There would be a need to establish the commercial viability of rafting on Pohopoco Creek, where it has not previously been done. Furthermore, both the DRBC and the Corps of Engineers own storage in Beltzville Reservoir. A determination would have to be made concerning which storage would be used to support whitewater rafting.

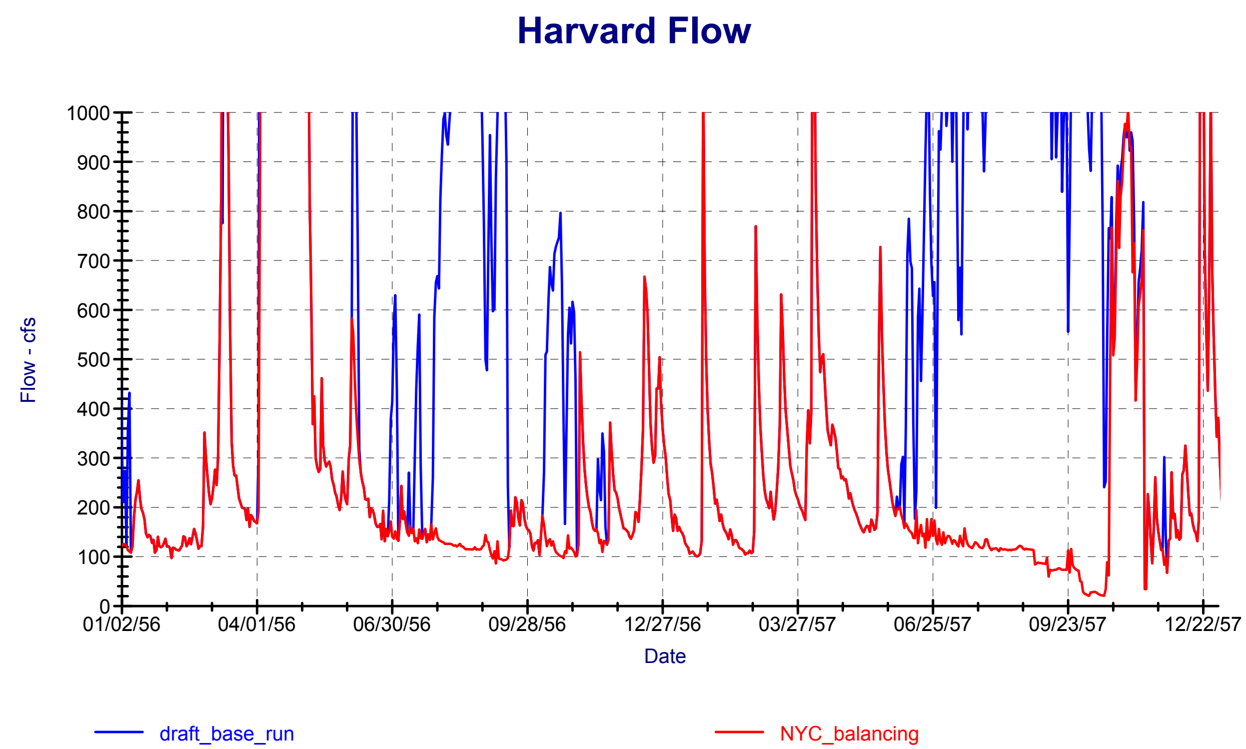
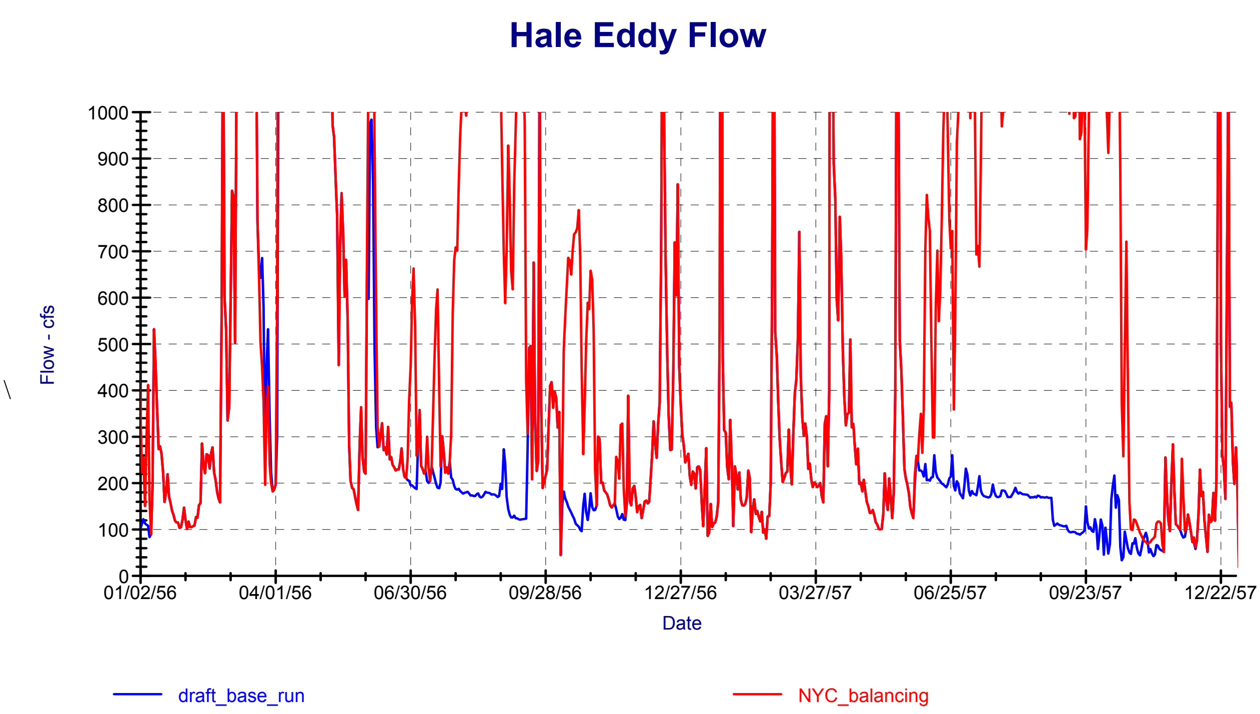


Figure 5.12



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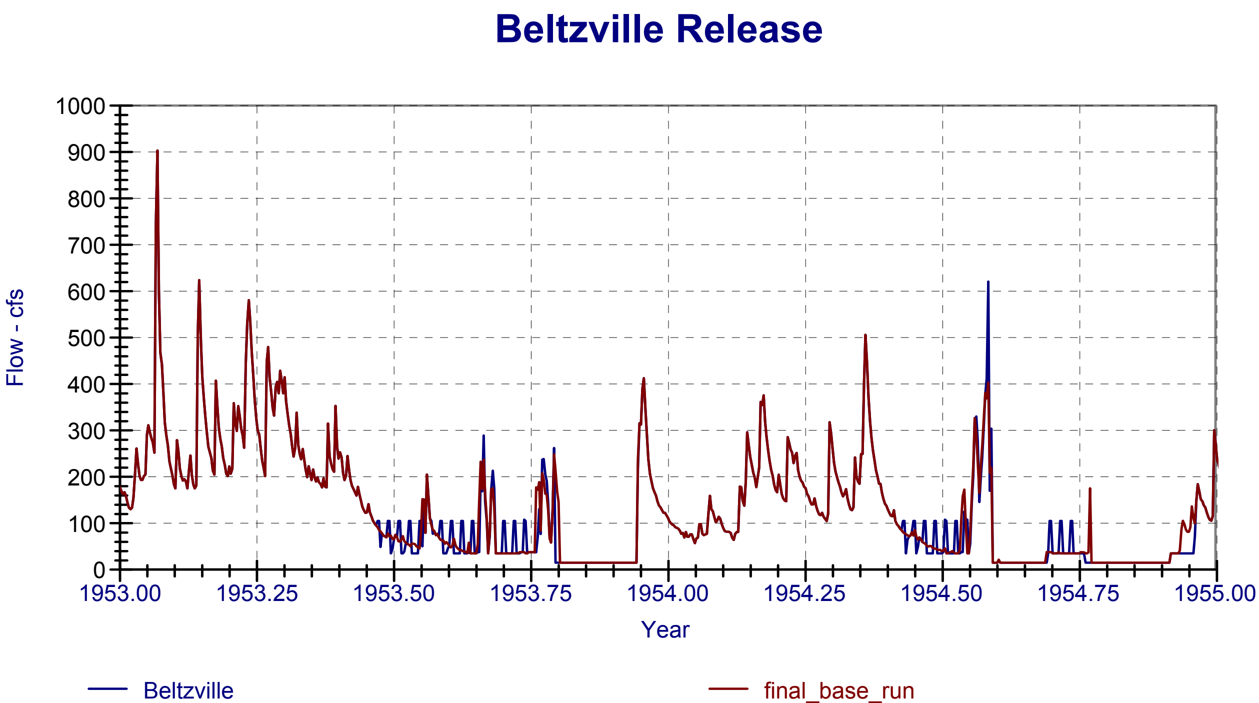


Figure 5.14

5.2.2 Case Study 5 - Temperature Control Below Blue Marsh Reservoir

The final case study (Blue_Marsh) considered how increasing minimum flows from Blue Marsh Reservoir on hot days might be used to control temperatures downstream on Tulpehocken Creek. The objective of such operations would be to enhance the cold water fishery below the dam.

Because there is no data on the relationship between temperature and flow downstream of this particular reservoir, a hypothetical relationship was postulated. That relationship assumes that the release necessary to maintain adequate water temperatures increased linearly with the daily maximum air temperature. For every one degree Fahrenheit that the daily maximum air temperature at a nearby temperature gage (in this case Libertyville, since data was readily available) exceeded 75 degrees, an additional 5 cfs of release from the dam was required. This release was in addition to the current minimum flow requirements. The maximum additional release was set to 100 cfs. As in Case Study 4, these additional releases stop when conditions in the Upper Basin fall to “watch” or conditions in the Lower Basin fall to “warning.” The modeled flows relate to temperature control only and are not the same as the flow rates recommended in Leroy Young’s study based on IFIM analysis (Young, 1999). Additional model runs could examine the effects of the habitat related flows recommended in Young’s study considering temperature control, provided that models for Blue Marsh Reservoir and Tulpehocken Creek temperature are developed. The U.S. Army Corps of Engineers data indicates that Blue Marsh has run out of cold water during the summer. Further analysis of a potential cold water release program would require analysis of this data to estimate the volume of cold water available for release.

Figure 5.17 shows the very modest impact that the example temperature release program would have on Blue Marsh storage. Note, particularly, the small drawdown in simulated storage in 1959. The impacts on total Lower Basin storage are almost identical to the impacts on Blue Marsh itself. The impacts on storage in the NYC reservoirs are very small as well. Figure 5.18 shows how the releases might be made in a hot year (1959), compared to the current release policy.

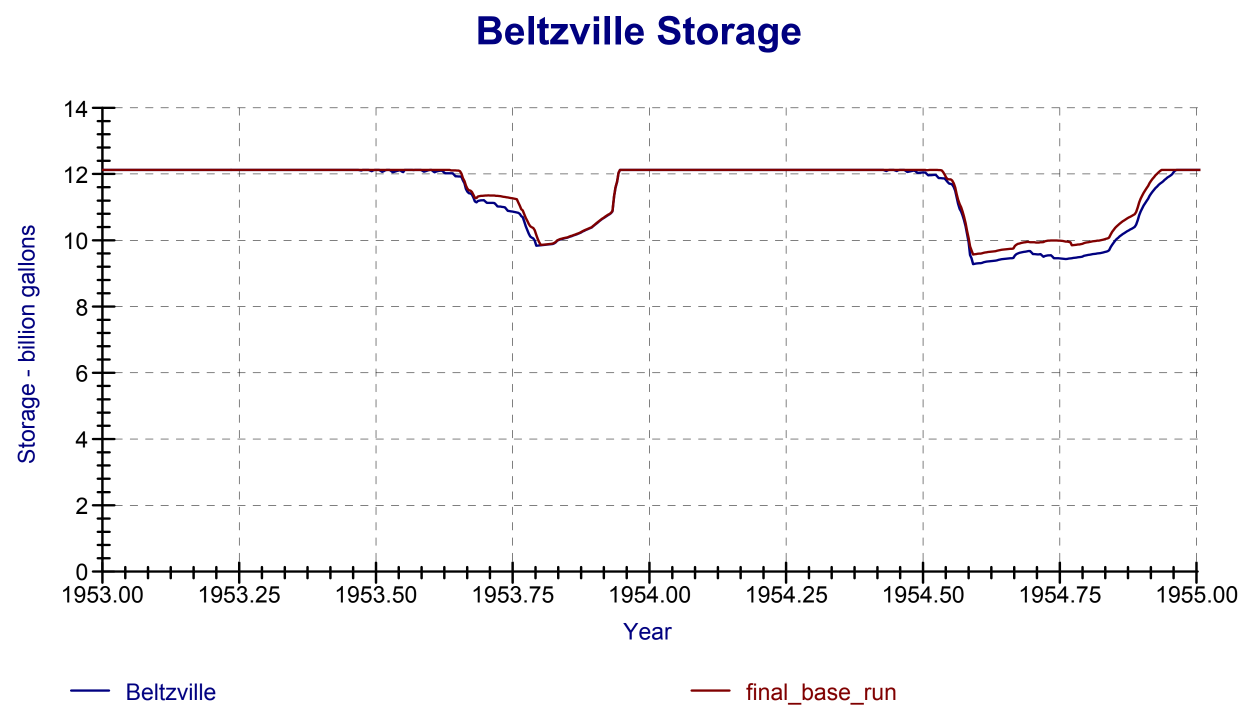
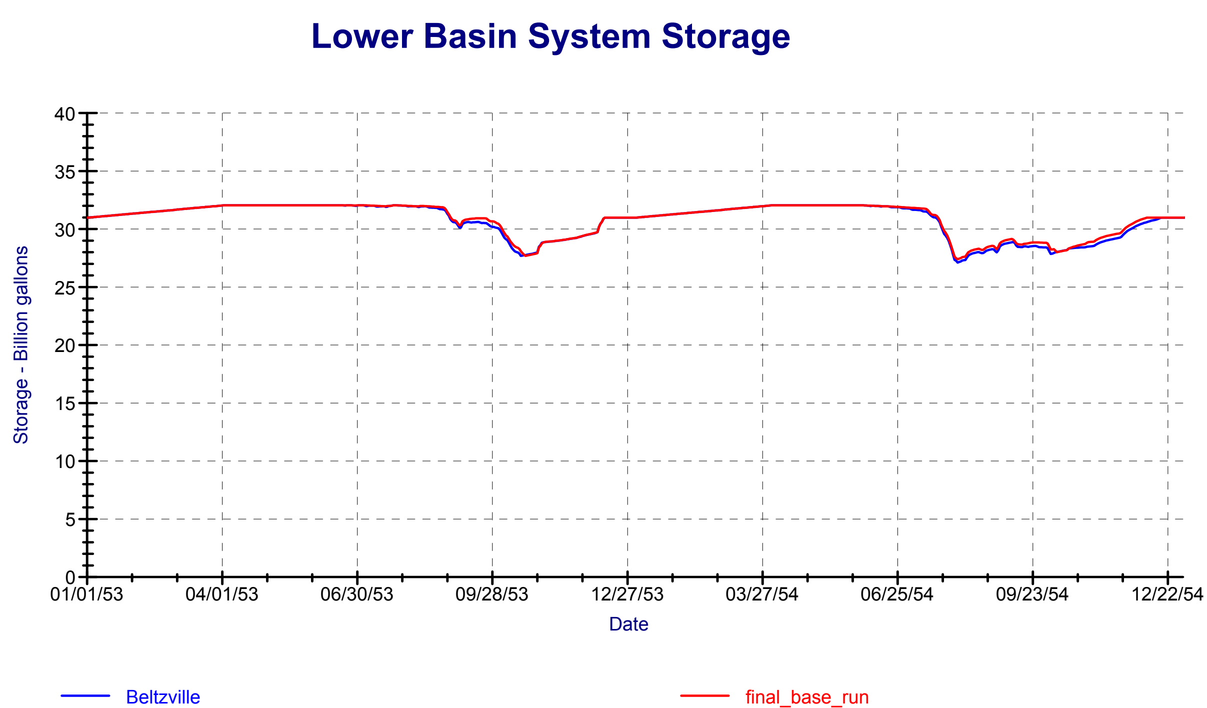


Figure 5.15



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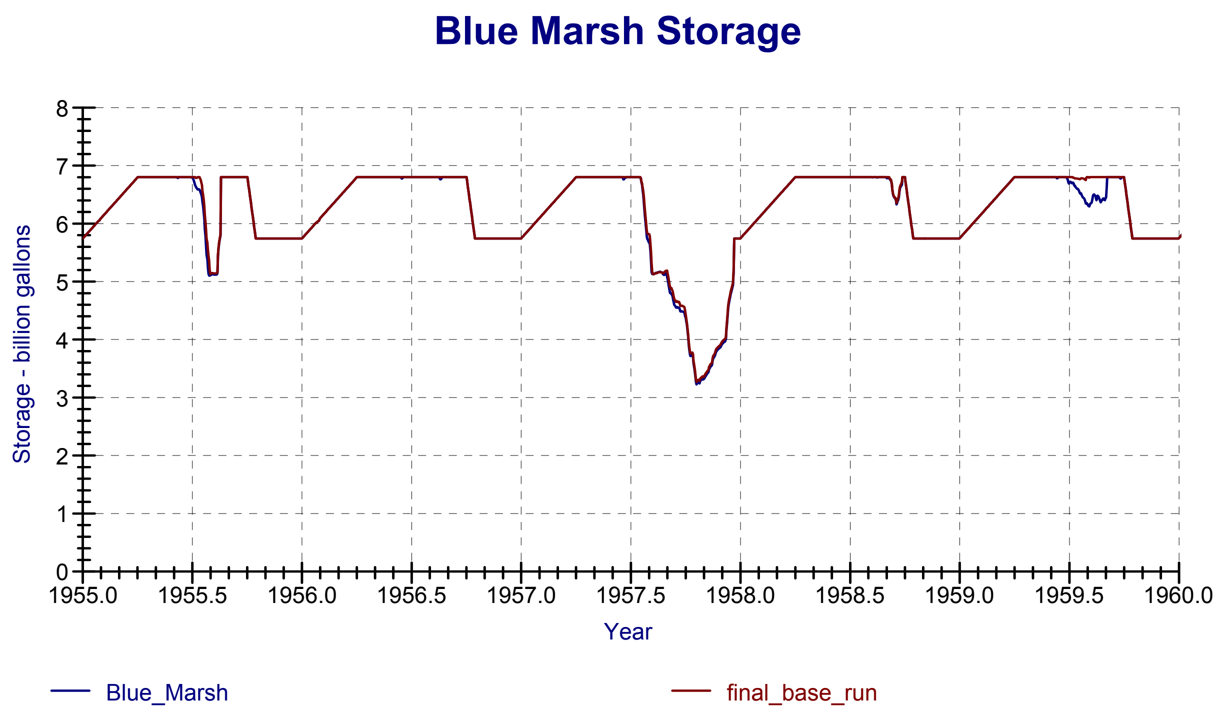

Figure 5.17

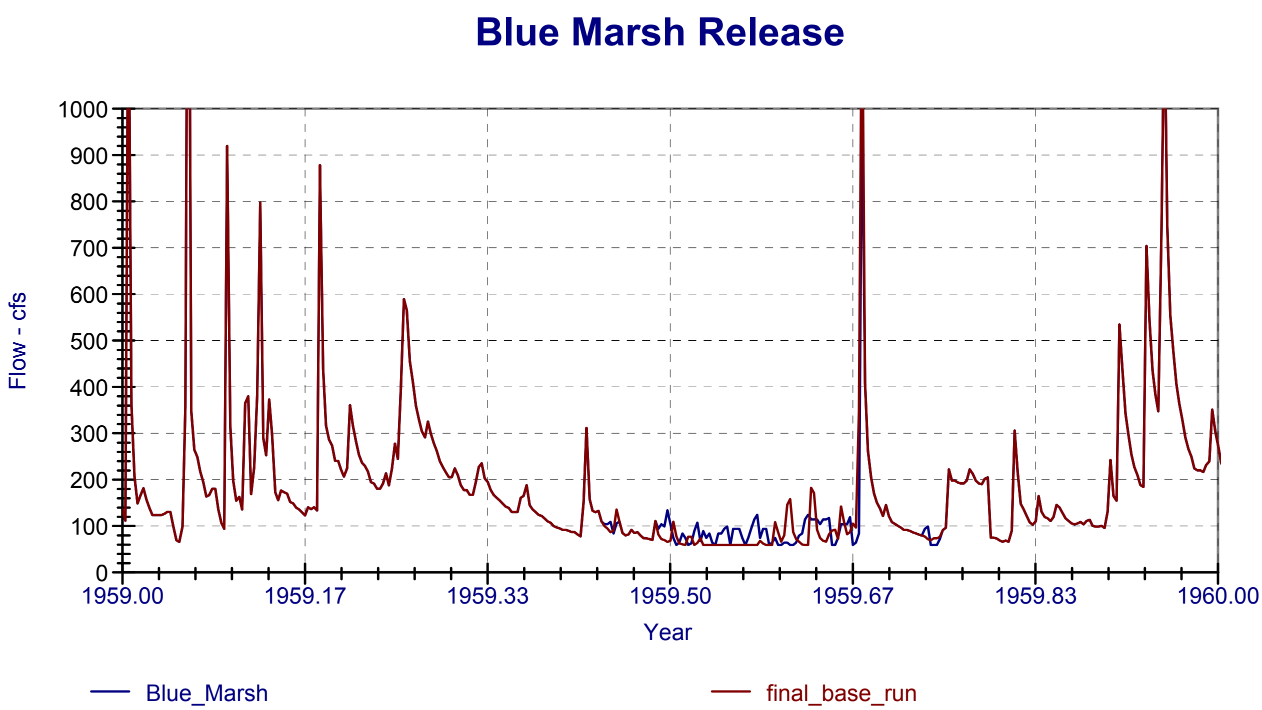

Figure 5.18